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Removal of Abnormal Snake Eggs by Sectioning

By CARL F. KAUFFELD

Although abnormal young, infertile eggs and otherwise anomalous conditions associated with the laying of eggs or birth of young in snakes are not rare, occasionally there are impactions of infertile egg masses or otherwise abnormal embryonic material that require surgical removal. Two cases treated recently in Staten Island Zoo seem to warrant description of symptoms and procedure.

An adult (1540 mm. total length) female Black Rat Snake, *Elaphe obsoleta obsoleta* was recently brought to us for treatment after nearly fourteen years of captivity (captured as a full-grown adult in August, 1939) in the Nature Workshop of the Newark Museum's Junior Museum. The snake had been isolated throughout its captivity until the past spring or late winter when a newly acquired male of the same species was placed with this snake. The female became gravid for the first time during its captivity, and developed fertile, albeit abnormally large eggs at least 45 mm. in diameter! Two eggs were laid over a period of five days, but it became evident that the remaining three eggs could not be thrown. When I first saw the snake, three widely separated masses bulged along the posterior fourth of the snake's body, the last apparently within the cloaca and distending the anal region. Attempts to force this first egg gently through the anal opening threatened to prolapse the cloaca so it was decided that surgical removal was inevitable.

An incision approximately 30 mm. long was made ventrally, somewhat to one side, at a point 150-180 mm. above the vent. This area was chosen as least likely to involve the kidneys, intestine and cloaca. The first egg was forced gently up from its cloacal position to the incision. This distended the oviduct sufficiently so that a short slit exposed the shell of the egg and prevented incising other tissues by mistake. The egg was removed by pinching the shell with a forceps and drawing it through the opening. The remaining two eggs were similarly removed by pressing them downward and pulling them through the original incision, but it was necessary to incise the oviduct each time because the collapse of membranous tissue after removal of each egg made it impossible to find the initial opening. Speed is essential to limit contamination. To avoid spreading the incision unduly the second and third eggs were slit and drained to facilitate their passage.

Four sutures were made with surgical needle and gut, the region was swabbed with Sulmet (25% aq. sulfamethazine Lederle) and then dipped in sulfanilimide powder. The area incised had previously been cleansed

with 60% ethyl alcohol. Sulmet was poured into the incision before and during the suturing. Pieces of oviduct that hung exposed were snipped off to reduce further the possibilities of contamination and infection. At the time of writing there have been no signs of infection, the incision seems to have begun to heal, and the snake's reactions have been normal even to the point of accepting a meal of a pre-killed quarter-grown white rat, ten days after the operation. There has also been normal elimination of uric acid and feces.

It is too early to make a definite prognosis but the indications are highly favorable. Past experience has shown that snakes rapidly recover from incisions and deep wounds if there is no injury to vital organs. Undoubtedly this snake will go through several skin moults in rapid succession—the sutures eventually falling out with a shed skin, with only a faint groove remaining to show the position of the incision.

A second case of similar nature presented itself almost within the same week as the above. This was a newly acquired Rainbow Boa, *Epicrates cenchria maura,* which was gravid on arrival, through fertilization in the wild. Several infertile eggs were thrown, but it soon became apparent that the snake had additional young or eggs to expel but could not. Examination showed at least two large extremely hardened masses posteriorly that could be felt distinctly by pressing the ventral region. These were assumed to be old infertile masses that were occluding the oviducts.

Using the same procedure as described for the Black Rat Snake, this snake was opened and our suspicions were confirmed. Two calcified masses, obviously of long standing and undoubtedly from an earlier gestation, were removed together with two dead, full-term embryos which had been more or less mangled, as if by two millstones. The incision was closed as before except that linen thread was used for suturing instead of gut, the latter being rather too stiff to be practical for our purpose. Again the snake has reacted very favorably and is expected to live indefinitely.

That such cases are not necessarily the result of conditions in captivity is borne out by the fact that the hardened masses removed from the boa were developed by the snake while in the wild. Another instance in my experience bears this out without question. A Pine Snake collected in southern New Jersey five or six years ago was found in a highly emaciated state, and exhibited a hardened mass posteriorly which moved quite freely, and was assumed, on this basis, to be an anomalous ovum rather than a tumor. (Contrary to popular belief, there is more pathology among snakes in the wild, and wild animals generally, than might be expected!) Again incision proved the diagnosis to be correct, and the mass was removed. Apparently this abnormal egg filled the body cavity and compressed the intestine so much that the passage of food was impossible—thus we account for the emaciated state of this snake. Subsequently food was taken avidly and weight increased rapidly. After a satisfactory state of flesh was attained, this animal was returned to its habitat and released.

That captivity can produce anomalous gestation is equally certain. It is especially true that female snakes brought into captivity while yet immature will, upon attaining maturity, often develop infertile eggs where there is no normal fertilization possible. I have seen numerous instances of this, but only one which required surgery. An Arizona Bull Snake,

Pituophis catenifer affinis, that had been collected as an immature snake, reached maturity after I had presented it to the School Nature Room of the American Museum of Natural History. About three or four years after capture the snake developed a "false pregnancy" — infertile egg masses were generated in large numbers as was discovered later. Attempts to throw these amorphous masses resulted in such a serious impaction in the pre-anal region that the lateral skin began to rupture. Injections of pituitrin produced obvious effort on the part of the snake to expel the eggs, but it was mechanically an impossibility. We incised ventrally and removed the masses individually—twenty-one, if my memory serves me correctly. Although almost completely amorphous, it was possible to remove them individually, but within the snake they were pressed together in one impaction that would inevitably have killed the specimen had we not taken measures promptly to remove them surgically. Recovery was complete and the snake lived for at least ten years after, eventually dying of some cause far removed from ovarian complication.

The operation is usually a remarkably bloodless one and requires very simple equipment: a new razor blade (or fine surgical blade of good quality and undoubted keenness), scissors, forceps, suture needle (not necessarily surgical), suturing thread (good quality linen has advantage over gut), antiseptics in the form of 60% ethyl alcohol, Sulmet, and sulfanilimide powder. Anaesthetics can be used, preferably local, such as ethyl chloride, but chloroform and ether are contraindicated due to the highly critical point of anaesthesia. There is little indication that the subject experiences much pain beyond the shock of the original incision which cuts through numerous nerve endings in the ventral shields, hence the local anaesthetic for the initial incision is all that is required. The greatest hazard encountered is damage to the kidneys and intestines and this can usually be avoided by reasonable care and reasonably good technique.

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STATEN ISLAND ZOO, NEW YORK

NOTES ON THE FEEDING HABITS OF *THAMNOPHIS S. SIRTALIS* IN CAPTIVITY. — Earthworms and amphibians make up the bulk of the local common garter snake's diet. Earthworms seem to be accepted more readily than frogs and toads. An average-sized snake will eat from two to four worms a week, although I have observed nine consecutive worms eaten by one specimen and eight by another. When tame, garter snakes will accept food from one's hand. If two are fed together, a struggle may arise over the worms which may cause some damage to one or even both specimens, so it is wise to feed them separately. More than one worm put in a cage at the same time may confuse the snake by moving when the snake has concentrated on a certain one; consequently, the reptile may move from one worm to another.

Unlike earthworms, which are grabbed by the head, tail or middle section, frogs and salamanders are usually eaten head first. The same principle is employed in eating frogs by *Coluber c. constrictor*. If the serpent seizes the frog or salamander in the midsection, it will work its way to the head before consuming it.

Garter snakes will vibrate their tails if they have a difficult time eating a worm, and if they don't succeed in conquering the worm, they may refuse to eat that day. After finishing a meal, garter snakes open their mouths several times, as if yawning. — WILLIAM HEALY, *30 Franklin Ave., Swampscott, Mass.*

RANGE EXTENSION FOR THE SPOTTED NIGHT SNAKE IN OREGON.—During September, 1952, Mr. William Troutman deposited a spotted night snake (*Hypsiglena ochrorhyncha*) in the Oregon State College Museum of Natural History (No. 8446). The exact collection date is lacking on this specimen, but it has been determined beyond doubt that it was picked up by Terry Ziegenhagen, 3½ miles east of Maupin, Wasco Co., Oregon, during July, 1952. The snake was found beneath a small boulder about 100 feet from the partly dry bed of Bakeoven Creek.

This spot was visited on May 8, 1953, by the author in company with Mssrs. Nathan Cohen, Philip Dumas, and William Troutman. Bakeoven Creek flows through a relatively deep, wide canyon. Hills sloping away from the creek are largely sage-covered, but there are frequent basaltic outcrops with talus slopes to the canyon floor. Scattered boulders and accumulations of boulders are common on the lower slopes and canyon floor.

This is the third locality record for this snake for the state of Oregon (Anderson, Occas. Pap. Coll. Puget Sound, Sept. 1940: 36-37; Storm and Pimentel, Great Basin Nat., Dec. 1949: 60-63) and extends its range approximately 85 airline miles west to the eastern base of the Cascades. This range extension suggests that *Hypsiglena* has a wide distribution through much of north-central Oregon.—ROBERT M. STORM, Department of Zoology, Oregon State College, Corvallis, Oregon.

AN ILLINOIS RECORD OF THE SCARLET SNAKE.—A snake in the Research Collection of Southern Illinois University Museum, formerly erroneously allocated, has been identified as *Cemophora doliata doliata* (Linnaeus) (=*C. coccinea* auctorum, fide Mittleman, Herpetologica 8, 1952: 25) by Philip W. Smith, Illinois Natural History Survey. The specimen, collected in Wolf Lake Swamp, Union County, Illinois, on July 26, 1942, by Fred Cagle, permits the first record of the occurrence of the genus in Illinois.

The scarlet snake ranges from southern New Jersey to Florida and west through Tennessee and Louisiana to Oklahoma (Perkins, Bull. Zool. Soc. San Diego, 24, 1949: 27). The species is also known from central Kentucky (Hibbard, Trans. Kans. Acad. Sci. 39, 1936: 281) and south-central Indiana (Minton, Amer. Midl. Nat., 32, 1944: 453). Although Davis and Rice (Bull. Ill. Nat. Hist., 1 (1), 1883: 34) credit *Ophibolus doliatus coccineus* to Illinois, it is clear from their generic synopsis that their *O. d. coccineus* is a synonym of *Lampropeltis triangulum syspila.* The closest unquestionable localities of *Cemophora* are in Kentucky and adjacent Indiana; the present specimen extends the known range approximately 160 miles to the north in the Mississippi Valley.

The SIU specimen, No. 542, is a male, 448 mm. in total length with a tail length of 66 mm. There are 19 body blotches and eight tail rings, and the red saddles are conspicuously lighter than the dark grey ground color. Scutellation data are as follows: 19 scale rows, 161 ventrals, 41 subcaudals, 6-6 supralabials, 6-7 infralabials, 1-1 preoculars, and 1-2 postoculars.—ESTHER BENNETT, Curator of Biology, Southern Illinois University Museum, Carbondale, Illinois.

ANOTHER RECORD OF THE SMOOTH GREEN SNAKE IN TEXAS. — In 1949 (Copeia, 1949: 223) I reported the capture of a specimen of the smooth green snake, *Opheodrys vernalis,* at a locality 2½ miles west of Sealy, Austin County, Texas, on April 23, 1949. I can now report the capture of another specimen at a locality 8 miles south of Sealy on April 26, 1953. The specimen, a female, was found in a meadow by Jude Kubicek, a resident in that area, and presented to me. Scale counts are as follows: scale rows, 15-15-15; ventrals, 148; subcaudals, 84; supralabials, 7-7; infralabials, 8-9; preoculars, 1-2; postoculars, 2-2; temporals, 1-2/1-2; scales smooth, anal divided; total length, 270 mm.; tail, 82 mm. Among recognized races, this specimen is also referable to *O. v. blanchardi* Grobman.

As a result of my first report of *O. v. blanchardi* from Austin County, Texas, Dr. Arnold B. Grobman (Copeia, 1950: 231-232) took me to task for lack of critical evaluation of my data. In his monographic revision of the genus (Misc. Publ. Mus. Zool., Univ. Michigan, 50: 16, 1941) he states that in the case of two specimens from Deming's Bridge, Matagorda County, Texas, "the locality record seems authentic, yet if a population of *v. blanchardi* does truly exist there, *or anywhere else along the Gulf Coast* (italics mine), other specimens probably would have been found during the fifty years that have elapsed since these specimens were collected." Two additional specimens have now been found on the Gulf Coast Prairie, one in 1949, the other in 1953. There the snake occupies a grassland habitat as it does in the Great Plains and other parts of its range.

A parallel situation is found in the prairie-dwelling 13-lined ground squirrel, *Citellus tridecemlineatus,* which has almost exactly the same geographic distribution as *O. v. blanchardi,* including a small population in the coastal area of Texas some 200 miles south of known records to the northward, and separated at present from that northern population by the post oak forest. Yet no one, so far as I am aware, contends that the coastal ground squirrels are out of their natural range.

Since smooth green snakes *do occur* on the Gulf Coast Prairie of Texas and they have been reported in the blackland prairie near Dallas (Waxahachie, UMMZ No. 84096), and since there is a record for "southern Oklahoma," it seems reasonable to assume that this snake has been subjected to similar ecological pressures experienced by the 13-lined ground squirrel in the Texas region, with both of them having natural, more or less relict populations on the coastal prairie that, at some time in the past, were derived from the present main body of the species to the northward and reached the Gulf Coast area by way of prairie corridors, such as the blackland prairies of central Texas. Such distributional phenomena in ecologically limited and relatively sedentary terrestrial species are frequently encountered. I agree with Dr. Grobman (Copeia, 1950: 232) that it is an investigator's responsibility to be critical in his evaluation of such records. But it is also his responsibility to take into account all data (ecological, geographical, and historical) before arriving at conclusions as to what constitutes the natural range of a species and to weigh all plausible explanations carefully before deciding that a record is invalid. — WILLIAM B. DAVIS, *Department of Wildlife Management, Texas A. and M. College, College Station, Texas.*

OBSERVATIONS ON THE EGGS AND YOUNG OF *DRYMARCHON CORAIS COUPERI*.—On April 13, 1953, a live five-foot five-inch specimen of *Drymarchon corais couperi* was captured in Estero, Lee County, Florida.

The specimen was taken to the writer's home where, on May 2, 1953, it laid six eggs. The average length of the six was two inches. The smallest egg measured one and three-quarter inches while the largest measured exactly three inches. The average diameter of the six eggs was one and one-quarter inches.

Ditmars in his *Reptiles of North America* states, "Its eggs equal those of a bantam in size." All the eggs laid in the writer's collection far exceed the size of a bantam egg.

During the summer (June 1-24) all the eggs were taken on a 3,000 mile trip. On returning, it was doubted if the eggs had remained unspoiled, as they had been jolted about in an automobile.

Two weeks after the eggs were laid, it was noticed that there were three small holes in the first one deposited. The albumen of the egg was flowing from these openings. On the following day, these holes were found to be sealed. On July 5, this egg was punctured to test its fertility. Again the albumen showed a fertile quality, and, as before, the egg mended itself. Upon opening, on Aug. 5, it was found to contain a living snake. The snake was removed and the allantois was severed two inches from the body.

The markings of the young snake were interesting. The rostral, internasals, upper and lower labials, lower jaw, and a portion of the throat were of a pinkish hue. A pattern like in the young of the genus *Coluber* showed very faintly through the usual blue-black coloration. The ventral scales for one-third of the anterior portion of the body contained two black spots (on each scale).

On August 6, a spoiled spot was found on another egg. The egg was immediately opened and was found to contain another living snake in development. Upon examination of the egg, it was plainly visible that the inside had begun to rot, but a protective covering had grown over the rotten area.

On August 8, the third, fourth and fifth eggs had hatched. The sixth snake had not appeared, although it had cut the egg for one-half an inch. On August 11, the egg was completely opened and the snake was found dead. This snake was fully developed externally.

The young snakes have an average length of eighteen inches. The smallest measures fifteen inches (this specimen was taken from the semi-rotten egg), while the largest measures twenty inches (hatched from the three-inch egg).

On August 16-18, the snakes molted. The blotch pattern is less visible and the pinkish hue has become more of a red-orange tone on three specimens.

On August 24, all of the snakes accepted Six-lined Racerunners (*Cnemidophorus*). Previous to this time, they had been offered Green Tree Frogs (*Hyla*), Leopard Frogs (*Rana*), Florida Swifts (*Sceloporus*), and Southern Ring-necked Snakes (*Diadophis*). None of the above were accepted, although the young snakes showed a great curiosity toward them. — CHARLES R. LEBUFF, JR., 1025 8th Ave. N., Naples, Florida.

A PASSIVE DEFENSE IN TORTOISES.—Turtles and tortoises generally are provided with a more or less impervious, passively protective shell with closures of varying efficiency. Box Turtles are notable for their highly efficient closure, the hinged plastron in most individuals forming a complete barrier against most enemies. Others, like the Gopher Tortoise, effect a fairly secure closure by the heavily scuted front feet being placed before the withdrawn head.

That the shell and closure mechanisms can be actively as well as passively protective is less well known. They can kill, even if by accident, small but persistent potential predators such as rats and mice, which actually do sometimes attack captive turtles. An example of this actively protective role was recently afforded by a *Testudo gigantea* in the Swope Park Zoo.

This turtle was often visited by rats in its hay-filled, open-topped enclosure. One morning a dead rat was found near the tortoise, which is an average specimen weighing 240 pounds. The carcass was somewhat crushed and not long dead. Three days later a second rat was discovered in a somewhat similar condition. No definite explanation was evident until a fortnight later when the tortoise awakened while being moved during cleaning. When disturbed by the motion, the tortoise extended the neck and forelegs, ejecting a large dead rat from the cavity. Apparently death was from suffocation as in the previous cases. That the limbs when withdrawn can produce considerable pressure in the cavities they then normally occupy was demonstrated by insertion of the foot into the limb cavity; the limb when withdrawn produced an unpleasantly tight squeeze.

Thus it may be inferred that at some times small marauders such as shrews and beetles chancing to enter the cavities about the limb insertions in relaxed tortoises would be killed by the retraction of the legs and that larger predators might be seriously injured.—DANIEL M. WATSON, 3733 Garfield, Kansas City, Missouri.

A NEW COUNTY RECORD FOR *MICROHYLA CAROLINENSIS CAROLINENSIS* IN MARYLAND. — On May 27, 1953, while collecting along the floodplain of the St. Marys River just northeast of Great Mills P. O., St Marys County, Maryland, an adult female eastern narrowmouth frog (*Microhyla carolinensis carolinensis*) was found beneath a decaying log partially imbedded in sandy soil. This specimen measured 35 mm. from the tip of the snout to the end of the body posterior to the vent.

This specimen is of particular interest in that it represents a new county record, and is the second record for the occurrence of this species in Maryland. The initial specimens of *Microhyla* were recorded from the Coastal Plain near Solomons Island, Calvert County, by Noble and Hassler in 1936 (Copeia, No. 1, pp. 63-64), at which time it was also heard calling at Cove Point a few miles away. Since the initial discovery of *M. c. carolinensis* in Calvert County, it has been observed and collected on numerous occasions at Cove Point, but no further specimens have been found at Solomons Island.

Recently, Hardy (1953, Herpetologica, Vol. 8, Pt. 4, pp. 162-166) has published detailed notes on the distribution of *M. c. carolinensis* in southern Maryland, basing his comments on the Calvert County records.

In this paper he points out that no specimens have been collected from other parts of the Maryland Coastal Plain, and suggests that *Microhyla* probably does not have a wider range in southern Maryland than these records indicate. He further contends that the Solomons Island-Cove Point colony is a relic population representing a former normal range periphery.

To account for the disjunct populations of *Microhyla* in southern Maryland and elsewhere in its range, Hardy suggests three theories: (1) an active and current northward emigration, (2) dispersal by hurricane (the Maryland population), and (3) climatic or environmental changes which took place subsequent to a northward emigration in postglacial time following a southward retreat caused by glacial chilling. In addition to these theories, four "more remote" explanations for the range fragmentation of this species are given: (1) overabundance of natural enemies; (2) an epidemic of disease in the breeding areas over a period of years; (3) the effects of small scale, but definite, climatic fluctuations; and (4) an inability to locate suitable breeding areas due to gradual environmental changes.

The fourth explanation seems to the writers to be the most applicable of the various theories and explanations suggested, although it requires qualification. There has probably been a drastic reduction of suitable habitats (including breeding areas) due to sudden and destructive changes brought about by ditching, draining, cultivating, logging, burning, etc. The reduction of suitable habitats through such activities would make those which remained more difficult to locate. No doubt more intensive collecting in the intervening areas between the various isolated populations of *Microhyla* will provide additional locality records, as is demonstrated by the St. Marys County specimen herein reported. As a result of this collecting, it may be discovered that the range of *Microhyla c. carolinensis* is actually more continuous than existing locality records would indicate.

The St. Marys County record also shows *Microhyla* to have a wider range in Maryland than was predicted by Hardy and establishes this species on the peninsula between the Potomac and Patuxent rivers. Subsequent collecting will probably reveal this frog to occur in other parts of the Maryland Coastal Plain where suitable habitats are still available. —J. A. FOWLER, Academy of Natural Science, Philadelphia, and C. J. STINE, Natural History Society of Maryland.

A Reconsideration of the Status of *Hyla phaeocrypta*

By PHILIP W. SMITH

Since the resurrection of Cope's *Hyla phaeocrypta* as the correct name for the Whistling Tree Frog (Mittleman, 1945), I have felt that it was our responsibility, in our forthcoming herpetofaunal report on Illinois, to confirm Mittleman's apparently sound conclusions, inasmuch as the type locality of *phaeocrypta* is Mt. Carmel, Illinois. After more than six years of field work, however, the species has not been found in the Mt. Carmel region or anywhere in the Wabash and Ohio River valleys. Dr. S. A. Minton has simultaneously explored southwestern Indiana with no more success.

As a last resort, I have undertaken to compare the *phaeocrypta* type with a homogeneous sample of Whistling Tree Frogs from Union County, Illinois, and with a series of comparable-sized Illinois specimens of *Hyla versicolor*. Sufficient discrepancies between Mittleman's and my own repeated measurements exist to indicate that his statistical data are not wholly reliable. A reconsideration of the morphological, ecological, and distributional evidence strongly suggests, as conclusively as is foreseeably possible, that *Hyla phaeocrypta* Cope is a junior synonym of *Hyla versicolor,* and *Hyla avivoca* Viosca is accordingly the valid name for the Whistling Tree Frog.

Acknowledgment is due to Doris M. Cochran for permission to study the type of *phaeocrypta*, to George H. Lowery for the loan of comparative material, and to Hobart M. Smith, Herbert H. Ross, Charles Fugler, and W. Leslie Burger for various aids and suggestions.

Hyla versicolor phaeocrypta was described from a single specimen collected by L. M. Turner at Mt. Carmel, Illinois (Cope, 1889). Viosca (1923) noted that a *versicolor*-like frog occurred in Louisiana which was however distinct in voice. He suggested that Cope's unplaced *phaeocrypta* might apply to his bird-voiced *Hyla*. Ridgway (1924) published a short note, reporting his recollection of having heard bird-like whistles during the day in the woods near Mt. Carmel. Knowing that these sounds were not made by birds, he suggested the possibility that these might have been Cope's *phaeocrypta*. In 1928, after having examined the type of *phaeocrypta,* Viosca concluded that Cope's type was within the range of variation of juvenile *H. versicolor,* and he proposed the name *avivoca* for the whistling Hylas. Meanwhile, various authors assigned the name *phaeocrypta* to aberrant specimens of *versicolor* found as far north as Minnesota and west as Kansas. Mittleman (*op. cit.*) analyzed samples of *versicolor* and *avivoca* biometrically, concluding that the subsequently proposed *avivoca* was a synonym of *phaeocrypta*. Neill (1948) split off the Atlantic Coastal Plain population of *Hyla phaeocrypta,* naming it *ogechiensis*. Edgren (1953) noted that a red linea masculina was an additional character serving to separate specimens of *phaeocrypta* from *versicolor*.

The most reliable character, aside from voice, for separating the bird-voiced *Hyla* from its sibling, *Hyla versicolor,* is the wash of bright green in the groin and on the rear of the femora (orange-yellow in *versicolor*). Cope did not mention voice, but he described the *phaeocrypta* type as having yellowish-brown on the concealed surfaces of the thighs. This

color disappears rather quickly in preservative, but to judge from material I have collected, the yellow may remain on the legs of *Hyla versicolor* for as long as five years in rare instances. No date of capture is indicated for the *phaeocrypta* type. It was probably relatively fresh when Cope described it, or color would not have been mentioned.

Ridgway's report of having heard a loud clear whistle near Mt. Carmel is difficult to evaluate. Ridgway placed a question-mark after the name in the title of his paper, however, and he stated that he was describing a boyhood recollection. These calls were heard during the day in the late summer or early autumn. It is therefore possible that his "piping" could have been that of *Hyla crucifer,* which species regularly resumes calling in the fall, particularly on warm days during September and October. Indeed, the "loud clear piping" is actually more descriptive of *crucifer* than *avivoca.*

Mittleman's diagnoses of *avivoca* and *versicolor* are for the most part adequate, and such features as coloration, song, skin texture, maximum size, and the suggested proportional differences are diagnostic characters. Several other statements, however, are questionable. (1) ". . . (the type) . . . compared with specimens of *versicolor* . . . these latter still have a characteristically pustulose and papillar dorsal surface." The *phaeocrypta* type is similar to *avivoca* in skin texture, but it can be matched by occasional specimens known to be *Hyla versicolor.* (2) "I have heard the species calling in mid-April." Our earliest date in Illinois (and 130 miles south of Mittleman's locality) is May 15, and it is known that in Illinois singing continues into August. (3) "I have heard the call of this species . . . along the Wabash River near the outskirts of Terre Haute, Indiana." Our best efforts have not revealed the species within 130 miles of Terre Haute. Moreover, this locality is adjacent to Clark County, Illinois, one of the parts of the state most intensively investigated. Considerable field work in southern Illinois has, in fact, revealed the species only in the Mississippi River floodplain of Alexander and Union counties. It is also of zoogeographic interest to note that all six of the truly Austroriparian amphibians entering southern Illinois extend farther north in the Mississippi Valley than in the Ohio-Wabash valleys. (4) "They apparently breed . . . in the same waters, and share the same general ecological niche." This is not true in Illinois. Breeding periods coincide, but not habitats, *H. avivoca* breeding in permanent swamps and *H. versicolor* in almost every other kind of water. (5) "Minimal male breeding size 29 mm. (in *avivoca*) . . . Minimal male breeding size 40 mm. (in *versicolor*)." Although the size range of breeding *versicolor* is appreciably greater than that of *avivoca,* the above statement is not absolute inasmuch as singing *versicolor* males as small as 31 mm. have been collected at breeding ponds.

Mittleman's ratios computed from measurements made with a vernier-scale caliper under low power of a microscope are quite different from those which I have made with dividers for body measurements and ocular micrometer for eye and tympanum diameters. Except for use of a micrometer for greater accuracy, measurements were made as Mittleman described. He finds an average difference of six per cent in the ratio of snout-vent hind leg length (minus fourth toe). I have not been able to rely on leg length measurements and have computed only the tibia/body length ratio. Mittleman finds slight differences in the interocular width/snout-vent length ratios and internasal distance/snout-vent length ratios. Due to

the great amount of overlap and the difficulty of measuring accurately, these ratios have not been investigated. The ratio of tympanum/eye, according to Mittleman, gives a complete separation of the two species and a mean difference of 17 per cent. I am unable to duplicate the ranges he found or to approximate his means despite repeated and carefully-executed measuring.

Moreover, the tympanum is proportionately larger in adults than in juveniles, and there is greater difference in this ratio between small and large specimens of *versicolor* than between *avivoca* and *versicolor*. This variation is summarized below.

TABLE 1. Ontogenetic variation in tympanum/eye ratios of *Hyla versicolor* (expressed in per cent)

Size	under 28 mm.	28-36 mm.	36-45 mm.	over 45 mm.
Range	44.5-59.0	50.0-66.8	51.9-82.1	52.9-67.9
Mean	52.5	58.2	60.1	62.4
Number of specimens	14	22	27	10

Since the type of *phaeocrypta* falls within the *avivoca* range and this ratio allegedly displayed no overlap between the two species, Mittleman felt justified in considering *phaeocrypta* and *avivoca* to be from the same population. His views were strengthened by the fact that he found the types of both *avivoca* and *phaeocrypta* to be identical in tympanum/eye ratio. Such statistics are meaningless if the frogs are inaccurately measured, and this seems to be the case. The *phaeocrypta* type is badly shrunken and the tympanum/eye ratio for different sides of the head varied approximately two per cent each time my measurements were taken. Furthermore, the ratio could not be exactly duplicated in measurements made on four different occasions. Averaging the ratios for the two sides of the head, however, the range of error is from 51.9-54.4 per cent and the mean for the four measurements is 52.6 per cent.

Selecting the size group of *versicolor* coinciding most closely with the size range of *avivoca*, which includes the size of the *phaeocrypta* type, the tympanum/eye ratios compare as follows:

TABLE 2. Tympanum/eye ratios for the type of *H. phaeocrypta* and samples of *H. versicolor* and *avivoca* (expressed in per cent)

	phaeocrypta type	*H. versicolor*	*H. avivoca*
Range		50.0-66.8	43.1-59.1
Mean	52.6	58.2	49.1
Standard Deviation		4.4	4.5
Size	30.8	28.0-36.0	27.8-37.0
Number of specimens	1	22	31

Thus, rather than a complete separation and a mean difference of 17 per cent, the above samples of *avivoca* and *versicolor* indicate considerable overlap in range and a mean difference of only 9.1 per cent. The ratio of the *phaeocrypta* type falls within the range of variational overlap and within two standard deviations of the means of both species when comparable-sized specimens are measured. The ratio of the type accordingly is useless in allocating the specimen since it could easily have been drawn from either population.

Other ratios for 31 adult specimens of *avivoca* from Union County and 20 approximately equal-sized specimens of *versicolor* from scattered Illinois localities similarly exhibit great overlap and preclude positive

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allocation of the type. These four ratios do suggest that the *phaeocrypta* type is more likely to be a specimen of *H. versicolor* since all four approach the *versicolor* means more closely than those of *avivoca.*

TABLE 3. Comparison of proportional ratios of *H. avivoca, H. versicolor,* and *H. phaeocrypta* (expressed in per cent)

	H. avivoca	*H. versicolor*	*phaeocrypta* type
Head/body	28.3-31.6	27.3-33.8	30.6
	(29.9±2)	(30.3±2.9)	
Eye/head length	33.0-43.5	30.1-41.5	
	(37.4±1.9)	(35.2±2.7)	31.8
Eye/head width	28.6-35.3	25.5-35.0	
	(32.7±1.9)	(30.2±2)	28.9
Tibia/body length	45.0-52.7	45.0-50.3	
	(48.5±1.8)	(46.8±2.2)	46.5
Size range in mm.	28.5-36.5	24.2-40.0	30.8
Number specimens	31	20	1

Ninety-five per cent of the *avivoca* material at hand have a distinctly divided subarticular pustule on the outer finger of the hand or an evident cleft in the pustule distally. Thirty per cent of a sample of 100 specimens of *H. versicolor* from localities throughout the range of the species have an indication of a distal cleft in the tubercle. Seventy per cent of the sample and the *phaeocrypta* type specimen have a simple subarticular pustule.

The status of Neill's *H. p. ogechiensis* is now uncertain. The Atlantic Coastal Plain population was diagnosed as having a larger tympanum (tympanum/eye ratio of 43.2-62.7, average 52.5), pronounced sexual dimorphism in size, and a yellow suborbital spot often stippled with brown. Neill's basis for comparison was admittedly taken from Mittleman's data, although he measured several series of the nominotypical race, pointing out that his ratios, unlike Mittleman's, were really intermediate between *versicolor* and *phaeocrypta.* Neill's ratios for Georgia *"H. p. phaeocrypta"* are remarkably close to those of *avivoca* from southern Illinois. Since *ogechiensis* and *avivoca* differ in tympanum/eye ratios by only three per cent and his series averages somewhat larger, this subspecific character is of questionable value. The relative tympanum size has been shown to increase with larger specimens of *H. versicolor* (see Table 1) and this same variation has been noted in *Hyla cinerea.*

Sexual dimorphism in snout-vent length is no more reliable than the tympanum size. Mittleman's largest specimen of *phaeocrypta* (=*avivoca*) was 40 mm. Mr. Charles Fugler of Louisiana State University has supplied measurements on a series of 37 Louisiana *avivoca,* which I had previously examined, and 42 per cent of the sample exceed 40 mm., the largest measuring 49 mm. Neill's series contained specimens up to 52.5 mm. The validity of *H. avivoca ogechiensis* thus appears to be contingent upon the constancy of the yellow suborbital spots with brown stippling.

Finally, Edgren's (*op. cit.*) statement that *phaeocrypta* is characterized by a red linea masculina must be considered. An examination of 33 specimens of *avivoca* and over 100 specimens of *versicolor* does not bear out Edgren's findings. To judge from preserved specimens of other species of frogs, the distinctness of the linea reflects the state of preservation and nothing more.

Although the similarities of *Hyla versicolor* and *Hyla avivoca* preclude positive allocation of the discolored and shrunken type of *phaeo-*

crypta, the close agreement of four of the five ratios (which can be computed with least fortuitous error) of *phaeocrypta* and a *versicolor* sample; the evidence in the nature of the subarticular tubercle; and all distributional and zoogeographic evidence point toward *phaeocrypta* as a specimen of *H. versicolor* as Viosca (1928) concluded.

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ILLINOIS NATURAL HISTORY SURVEY, URBANA

THE HOG-NOSED SNAKE IN ALBERTA. — The existence of *Heterodon nasicus* in Alberta has been known for many years but the literature dealing with the reptiles of this Province contains no reference to its presence. It is desirable then to place on record our information concerning this species.

Specimens collected at Empress, Medicine Hat, Craigmyle, Comrey, and Manyberries have been examined by the writer and all are referable to *Heterodon nasicus nasicus* Baird and Girard. These records show that the range of this subspecies includes a large part of the prairie area of southern Alberta. Our data on occurrence indicate that these snakes have a preference for sandy locations and also damp lowlands in this region.

Since relatively little appears to be known about the reproductive activities and growth of western hog-nosed snakes, it is of interest to note certain observations relating to 2 specimens obtained in the Empress area. On July 13, 1951 Mr. R. Lister and the writer collected an adult female (total length 22⅛″) by a roadside pool near Empress. This specimen remained alive until July 25 and laid eggs on July 19, 20, 21 and 23. Of the four eggs deposited, that of July 21 measured about 1⅛ x ½″. On dissection, this snake was found to contain 7 additional eggs. A juvenile individual taken also on July 13 had a total length of 7⅜″. It seems likely that this specimen hatched during the previous summer and that growth during its first year was not extensive.—J. E. MOORE, Department of Zoology, University of Alberta, Edmonton, Alberta.

Further Evidence of the Venomous Nature of the Saliva of *Hypsiglena ochrorhyncha*

By JOHN D. GOODMAN

Cowles (Copeia, 1941:) presented evidence that the bite of the Spotted Night Snake, *Hypsiglena,* was fatally toxic in many cases for small lizards (*Coleonyx, Uta, Xantusia*) under laboratory conditions. His conclusions were that when deaths occurred the lizards succumbed to the venomous effects of the bite and not to any sort of a mechanical injury at the site of, or resulting from, the bite. Cowles stated that death often occurred within forty-five to forty-eight minutes. His were laboratory observations. The present paper is an account of an actual field observation of the capture and the events following the capture of a small lizard by a Spotted Night Snake.

On the evening of June 16, 1953, at 7:20 p.m., just at sunset, I was quietly observing through binoculars the nest of a bird at 6,400 feet elevation in Snow Creek Canyon, San Bernardino Mountains, near Fallsvale, California. Suddenly, directly at my feet, I sensed a disturbance among the rocks. Upon looking down, my first impression was of a small lizard, *Sceloporus graciosus,* wriggling and bending furiously in an attempt to get its own tail in its mouth. Then I saw that the base of its tail was in the grasp of a small snake, of which only the head was visible, the greater part of the snake being out of sight beneath a rock. The snake was immediately identified as *Hypsiglena.* The lizard was unable to grasp the snake due to the very small portion of the snake protruding beyond the rock and the inability of the lizard to flex its body sufficiently to reach the head of the snake fastened at the base of its own tail. After the brief preliminary bending and wriggling were over, the lizard ceased altogether its struggling movements. I noted the time then as exactly 7:20. The wriggling period had taken only ten or fifteen seconds, certainly no longer. The lizard was now motionless, but twisted at an acute angle to the left with its jaws at the level of its left hind leg, its head bent forward at an angle with the neck so that there was a distinct downward slope from the back of the head to the snout. Both animals remained perfectly motionless in this precise position for 8½ minutes, when the tail of the lizard began to wave very slowly, then stopped. No movement of any kind was evident from either animal until 10 minutes later when the tail of the lizard again began to wave, this time almost imperceptibly, for a few seconds and then stopped. At 22 minutes from the time the struggle had ceased, the snake jerked suddenly upward and backward, with no response elicited by the lizard. This seemed to be some sort of a signal, for the snake now began to vigorously chew the base of the lizard's tail. The mouth was opened widely and then closed, and for the first time blood was observed to ooze out from the wound in the tail and around the snake's jaws. Occasionally, the snake opened its mouth very widely, when the lizard could easily have escaped, but it never attempted to free itself at these times. While chewing, the snake always kept its head bent forward in the same characteristic manner, presumably so the saliva had its best chance of flowing to the interior of the mouth and into the wound. This period of vigorous chewing lasted for only seven minutes. At 29 minutes, the chewing abruptly ceased and the snake began slowly to remove its body from beneath the rock, all of the time keeping the same hold on the tail of

the lizard. It then slowly began to lift the lizard upward in an attempt to remove it from the stone and the stick to which it was clinging. It first dragged the right hind foot free of the stone. This was accomplished with some difficulty, although during the whole time the lizard seemed completely paralyzed. The worst trouble came in freeing the two front legs from their hold on the stick. The snake, being at the lizard's tail, was not in a position where it could lift them free and at first attempted, unsuccessfully, to drag the lizard backward and thus free the forelegs from the stick. It finally succeeded, however, after about ten minutes of dragging, pushing and pulling from side to side. When the lizard was finally worked free, it was then slowly dragged backward along the ground between rocks for about a foot, once even being pulled up over an intervening horizontal stem about three inches high. The snake first threw its own body backward over the stem and then dragged the lizard upward and over it, the whole thing being accomplished with surprisingly little apparent effort. The most remarkable thing was that all of this time the lizard remained completely rigid and motionless and twisted acutely to the left as when first captured. About this time it was noted that the snake was dragging its captive to a hole underneath a very large boulder against which I had been leaning. It was therefore necessary that I capture the snake, which I did by leaning down and picking it from the ground. It immediately released its hold on the lizard, which, to my complete surprise, began slowly, with great difficulty, to wriggle away. I easily captured the lizard, and carrying one animal in each of my hands, returned to my cabin. In the ten-minute walk to the cabin I had time to carefully notice the swollen, much-chewed condition of the lizard's tail, from which blood freely oozed. There was no evidence of discoloration. The lizard wriggled once in my hand seven minutes after picking it up. After that, it became limp and extended in my hand so that I felt sure at that time it was dead. This was exactly 45 minutes after its initial capture. After getting home, I placed the lizard in the refrigerator, 58 minutes after its capture by the snake, and presumably dead. At 65 minutes, there was an occasion to open the refrigerator, and the lizard was vigorously wriggling within its jar. It was immediately removed and placed under observation, behavior being recorded at half-minute intervals for the next 59 minutes. It did not respond at any time to vigorous pinching of any of the toes, nor was it able to right itself when placed on its back, although once at 109 minutes and again at 113 minutes it made spontaneous movements in an attempt once to turn from an upright position onto its side and the second time it attempted to right itself when placed on its back. Each of these attempts was accompanied by vigorous crawling motions of the front legs, while the hind legs were not used and were believed to have been completely paralyzed. Its eyes became closed at 70 minutes and were never opened again, even when annoyed about the head region. The most conspicuous action during this period was its respiratory movement. At approximately one-half minute intervals for over thirty minutes before its death, it would suddenly open widely its mouth and sharply gasp for air. At these times, the thorax was not observed to expand, the breathing being very shallow. It occasionally moved its front legs very slightly, but its hind legs were never moved during the entire period of observation. At about this time, the right rear leg was noticed to be highly discolored with bluish-green; pressure with a pencil point produced a pitted edema. It was not con-

spicuously swollen, but rather seemed somewhat shrivelled. This leg was never observed to have been grasped by the snake at the time of the original capture, yet the appearance now of the extreme discoloration of the leg pointed directly to some connection with that event.

At 118 minutes, the lizard appeared to be dead, so it was placed belly-up in my hand. When no movement was elicited, it was turned belly-downward and the head and neck vigorously poked with a pencil. It responded to this by turning its head downward, trying to curl it under its body. All of this time, the eyes remained closed and the rest of the body had become apparently paralyzed. At 120 minutes, the tongue was protruded slightly beyond the end of the snout and the animal ceased to gasp for air. Although it was observed for an additional four minutes, it was decidedly dead before that time was over.

The above observations corroborate those of Cowles that *Hypsiglena* is capable of delivering a fatal bite to small lizards. There is evidence that the bite is both neurotoxic, producing paralysis of an ascending type, and to a lesser degree, hemorrhagic in nature, capable of producing on occasion a localized discoloration of the tissues. The relatively longer time for death to occur in the present observation may have been due to the extremely small size of the snake. It measured 185 mm., about 7¼ inches, while the lizard measured 33 mm., snout to vent.

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THE GEORGIA TREE FROG, *HYLA GRATIOSA* LECONTE, IN NORTH CAROLINA. — The Georgia Tree Frog, *H. gratiosa,* was first added to the North Carolina list by Dr. B. B. Brandt, who found the first specimens in a small woodland pool near Washington, N.C., in June, 1932.[1] The next year, they were first heard calling on April 20 and two mated pairs were taken in the same locality. Later the same season, eggs and tadpoles were also secured.[2]

No further record of this frog occurring in North Carolina was made until August 21, 1951, when one was taken at Masonboro Sound, New Hanover County, by C. H. McAllister, Jr. This specimen is now in the collection of East Carolina College, Greenville, N.C. Although an extensive search was made for this species during the next breeding season, it was not until May 1, 1953, that they were again found, when a large chorus of these frogs was heard in an inaccessible swamp at the head of Whiskey Creek on Masonboro Sound. Others were heard calling at a small grassy pond near Winter Park the same evening, and one specimen was secured. On May 6, 1953, five *H. gratiosa* were secured from Silver Lake near Carolina Beach, including one mated pair. Since that time, they have been found in numerous other localities in New Hanover County.

During the evening of June 22, 1953, I secured three specimens of this frog from a small colony of ten calling in a flooded sand pit near Chinquapin, N.C., in Duplin County. Both New Hanover and Duplin counties are located in the outer coastal plain and these specimens add considerably to the known distribution of this frog in North Carolina.

[1]Brimley, C. S.
Reptiles and Amphibians of N.C., Carolina Tips, Elon College, N.C., 1941-43.
[2]Brandt, B. B.
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A New Subspecies of Racer, *Masticophis flagellum*, from the San Joaquin Valley of California

By BAYARD H. BRATTSTROM and JAMES W. WARREN*

The existence of color variants in the western racers of the species *Masticophis flagellum* have been noted for some time. The general ground color may be black, brown, red, or yellow with various shades between. With the exception of the black form, these color phases have never been considered sufficient genetic entities to deserve taxonomic recognition. It appeared that the colors occurred at random throughout the distribution of *M. flagellum* in the western states and, for this reason, they have been regarded as relatively unimportant. The writers, however, feel that if it could be shown that a color phase is effectively isolated and constitutes a fairly homogenous population with respect to color, banding, flecking, etc., it should be recognized as a race genetically different from other members of its species. Working on this premise, we describe below a subspecies of *Masticophis flagellum* from the San Joaquin Valley, California.

The San Joaquin Valley lies in central California. It is about 425 miles long and about 50 miles wide. It includes or is continuous with the Sacramento Valley. It is bordered on the west by the Coast Ranges and on the east by the Sierra Nevada range. Where the land is not under cultivation, the valley is typically Lower Sonoran. The dominant vegetation is grassland or Oak-Savannah. It is bordered by *Atriplex-Eriogonum* association, Chaparral, or dense Oak-Savannah. The discovery of a subspecies of racer from the valley is not too surprising as the valley seems to lend itself quite well to the preservation of variants of larger populations. Notable examples of this are *Gambelia silus* and a subspecies of *Sceloporus occidentalis* (Bell, ms.), both of which are restricted to the valley.

The work leading to this publication was made possible by a research grant from the Richfield Oil Corporation and has been carried out under the direction of Dr. Raymond B. Cowles. We wish to thank Dr. L. M. Klauber for use of the San Diego Society of Natural History (SDSNH) and L. M. Klauber (LMK) collections as well as for the use of his extensive scale counts, and Dr. Robert C. Stebbins, University of California at Berkeley, for use of the specimens in the Museum of Vertebrate Zoology (MVZ). We also wish to thank Dr. Clark P. Read, Department of Zoology, University of California, Los Angeles, for his criticisms and suggestions. We name the subspecies for Dr. John C. Ruddock, Medical Director for the Richfield Oil Corporation.

Masticophis flagellum ruddocki new subspecies

Holotype. An adult male, number 6108 in the collection of the University of California at Los Angeles; collected ¼ mile south of ridge at Wheeler Ridge and 1½ miles west of U. S. Highway 99, Kern County, California, on April 12, 1953, by James W. Warren.

Diagnosis. A consistently light yellow racer lacking the dark head and neck bands of the red forms of *Masticophis flagellum piceus.*

Range. San Joaquin Valley (including the Sacramento Valley) of California and side valleys of the San Joaquin Valley extending into the Coast Ranges to the west.

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Description of holotype. Adult male; length overall 1383 mm.; tail length 343 mm.; ventrals 197; caudals 105; supralabials 8-8; infralabials 10-10; preoculars 1-1; postoculars 2-2. The color varies from spots of Aniline Yellow on the sides of the head and neck to a solid ground color of Buffy Citrine on the sides of the body and Saccardo's Olive dorsally. The ventral color is consistently Straw Yellow (capitals are Ridgway's Color Standards, 1912), with Aniline Yellow or black on the lateral edges. The top of the head is light brown with two dark spots on the supraoculars. There is a small postocular brown stripe on the edge of the postocular and anterior temporals. The labials each have a dark spot and the anterior ventrals have Aniline Yellow spots on them. There are two faint lateral light stripes on the anterior one-third of the body. This is caused by the first scale row being yellow-tipped at its dorsal and ventral corners. There is no evidence of any neck banding.

Paratypes. MVZ 27006, Eight miles SSE of Avenal, Kings County; a topotype, UCLA 6107, Wheeler Ridge (in this specimen the ventral edges are brown-tipped and occasional dorsal scales are tipped with black at their posterior margin; two obscure yellow-brown bands); UCLA 6032, Cuyama River bed at State Highway 166, San Luis Obispo County.

Referred Specimens. MVZ 2765, 2766, 2767, 2768, 2769, 6836, 18531, 26201; LMK 1986, 23964, 26084, 31531, 37428; UCLA 6065.

Distribution. In addition to the specimens mentioned above, we have taken notes on D.O.R. specimens that are damaged beyond preservation. Localities where *M. f. ruddocki* has been taken or observed are as follows (all localities are in California):

Fresno Co.—Coalinga, 4 miles southeast of Coalinga. Kern Co.—2 miles southwest of town of Wheeler Ridge (type locality), 1 mile north of Edison, 8 miles northeast of Bakersfield, McKittrick, Lerdo, ¼ mile north of Buena Vista Lake, 1 mile east of Fellows, 11 miles northwest of Keene. Kings Co.—8 miles SSE of Avenal. Monterey Co.—3 miles south of San Lucas. Sacramento Valley. San Luis Obispo Co.—7 miles southeast of Simmler, 7 miles southeast of Shandon, Cuyama River Valley at State Highway 166 (about 5 miles west of junction with Highway 366). Tulare Co.—Earlimart.

Discussion. The general Buffy Citrine to Saccardo's Olive color does not differ on any of the specimens seen. Occasionally obscure neck bands are present, but if so, they are of the same ground color as the rest of the snake, never black as in most *M. f.piceus* (red phase). The number of dorsal scales flecked with black varies in the specimens examined. The lateral light lines may become obscure on light specimens, and they may increase in intensity and number up to 4 or 6, especially in the Sacramento Valley portion of the San Joaquin Valley. A summary of the scutulation of all specimens of *ruddocki* seen is as follows (number in parenthesis is the mean): ventrals 193-199 (195), caudals in males 101-106 (103), caudals in females 94-104 (98), supralabials 8-9 (8), infralabials 10-11 (10.4), preoculars 1-3 (2), postoculars 1-3 (2), scale rows decreasing in the order 17-15-14-13. The largest specimen we have seen was 1,710 mm. long.

M. f. ruddocki has probably been derived from *M. f. piceus* from which it differs in color, in the absence of black neck bands, and in a lower caudal count. The ranges of the two forms contact each other only through the passes of the southern end of the Sierra Nevada and Tehachapi Mountains. We have examined five specimens which we consider

to be intergrades between *ruddocki* and *piceus* in South Fork of the Kern River-Walker Pass area and one specimen from the Tehachapi pass area, Kern County, California. These are MVZ 2792, Kern River at Bodfish (black neck bands, ground color yellow, but tending toward pink); MVZ 56717, 6 miles SSE of Weldon (black neck bands, color pink, but not red); MVZ 2793, Weldon (distinct dark neck bands, ground color yellow); MVZ 2794, Isabella (dark neck bands); UCLA 6106, 1 mile east of Onyx (one distinct and one obscure neck band, ground color red); and LMK 27422, Monolith, Tehachapi Mountains (yellow, neck bands dark but obscure). Intergradation between *ruddocki* and *piceus* probably also occurs in the Tejon Pass-Gorman area as well as other passes through the Tehachapi Mountains.

The type locality of *M. f. ruddocki*, Wheeler Ridge, is an east-west running ridge in the southern portion of the San Joaquin Valley in Kern County. The ridge lies about 2 miles southwest of the town of Wheeler Ridge which is on U. S. Hy. 99. The dominant vegetation at the type locality is low grass. Common annuals are *Orthocarpus purpurascens* and species of *Lupinus, Oenothera, Clarkia, Phacelia,* and *Amsinckia.* The only perennials are a few *Atriplex* sp. that are restricted to the margins of small alluvial fans on the south side of the ridge.

Because we have described *ruddocki* primarily on the basis of color, we feel that it might be well to clarify our position on the taxonomic status of the black forms of *M. f. piceus* of Baja California and Arizona. No new additions have appeared to challenge Klauber's (1942) conclusions that the black racer (*M. piceus*) is merely a color phase of the red phase (*M. f. frenatum*) (=*M. f. piceus*). We feel that intensive study will support some of Ortenburger's (1928) observations on the distinct ecological separation of these two forms. Ortenburger, however, came to the conclusion that the black racer (*M. piceus*) deserved specific recognition. We feel that because of the existence of a few specimens which appear to be intergrades, the black racer should only be considered a race of the red racer (*M. f. piceus* and *M. f. frenatum* respectively). As for the black forms of southern Arizona, it is quite possible that these represent another subspecies whose closest affinities are with the black racers of Baja California. (If so, it would become *M. f. piceus* and the Baja California form named new.) Such a disjunct distribution need not cause undue surprise in light of other recent works dealing with the same situation in almost the same area. We refer to the relationship between *Crotalus viridis helleri* and *Crotalus viridis cerberus* (Klauber, 1949) and to the possible relationship of *Lampropeltis zonata* to *L. doliata gentilis* (Zweifel, 1952).

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On the Validity of *Taricha torosa klauberi* Wolterstorff

By BAYARD H. BRATTSTROM and JAMES W. WARREN

The validity of the salamander *Taricha torosa klauberi* Wolterstorff has been questioned ever since its description in 1935. The subspecies was differentiated primarily on the basis of an extremely warty condition. These prominent tubercles were found all over the body of specimens from Boulder Creek (type locality) and Cedar Creek, San Diego County, California.

Twitty (1942) and Myers (1942) suggested that *Triturus torosus klauberi* (=*Taricha torosa klauberi*)* was invalid. Myers suggested that the short snout and the warty condition (which appeared to increase with age) were correlated. Microscopic sections of the skin of specimens from the type locality studied by Twitty (1942) indicated a pathological condition although no parasites could be found. However, Bishop (1947) considered *klauberi* as a distinct species of *Triturus*. Wahlert (1952) and Stebbins (1951) subsequently questioned the validity of *klauberi*. Stebbins' (1951) conclusions were based on three facts: warty individuals were found elsewhere (San Luis Obispo County, Stebbins, 1951, and Palo Alto, Twitty, 1942), the warts appears to be a pathological condition, and, in other respects, non-tuberculate individuals from San Diego County are indistinguishable from tuberculate forms.

In the last several months we have gathered some further evidence which shows that recognition of *klauberi* is not justified. This research has been supported by a grant from the Richfield Oil Company.

On May 10, 1953, the senior writer and Mr. William McFarland collected *T. t. klauberi* in Boulder Creek for use in some temperature experiments. We observed that most of the individuals caught were not warty. Actual counts on 43 specimens showed that only 2 (4.7%) were warty and these two individuals were mainly warty on the belly with a few warts on the head. Five individuals in this collection had only one or two warts on the belly, and these are termed "Partly warty" and are not counted as "Warty" in figuring the percentage of incidence of the warty condition (Table I).

TABLE I

Samples of *Taricha torosa*, from Boulder Creek, San Diego County, California.

Date	Total	Warty	Partly warty	Non-warty	Percent warty
7/5/28	19	17	2	0	86.8
3/1/42	28	18	9	1	64.2
5/30/48	19	2	3	14	10.5
5/10/53	43	2	5	36	4.7
6/28/53	105	4	11	90	3.8

A second check by the writers on June 28, 1953, yielded the same result (Table I). On this date we traveled Boulder Creek for about two miles collecting and checking for warty individuals. We then checked the museum specimens in the collection of L. M. Klauber and the San

* We follow Wahlert (1952) and others in recognizing the validity of the genus *Taricha* for western North American salamandrids usually referred to as *Triturus*.

Diego Society of Natural History and counted the number of warty individuals collected on various trips to Boulder Creek in the past. These are presented in Table I. We are assuming that these are random samples of the population. We know that the 1942 collection was a random one (Charles E. Shaw, personal communication). Samples of less than 19 individuals were not used though they showed the same trend (1932, 1 out of 1 warty; 1933, 1 out of 1 partly warty; 1934, 3 out of 3 warty; 1950, 1 out of 1 non-warty). It is apparent from Table I that the percentage of warty individuals in the population at Boulder Creek has slowly decreased from 86% in 1928 to about 4% in 1953. Hence the form *Taricha torosa klauberi* Wolterstorff, which is based primarily on the warty condition, is invalid.

Laboratory experiments in which non-warty adults from Boulder Creek were kept at temperatures of 4°, 14°, and 24°C. for periods of two months (usually for at least one shedding) yielded no results as far as wartiness is concerned. Negative results were also obtained with individuals placed in aquatic or terrestrial aquaria, either at 14° or 27°C. (Water temperatures of Boulder Creek on May 10, 1953, varied from 15.8° to 16.4°C. and on June 28, from 22° to 27°C. Body temperatures on the latter date varied from 22° to 23.8°C. or essentially the same as the water in the particular pool from which the animal was taken. The upper lethal temperature varies with past thermal history, McFarland, ms.). Aerated or stagnant water also produced no warts in non-warty individuals.

High salt (NaCl) or increased copper content of the water had no effect on the warty or non-warty individuals. The increased copper content of the water was produced by placing several copper pennies in the container with the newts. Mr. Arlan Smith of this department uses pennies in aquaria containing axolotls to keep the growth of fungi and bacteria down. Pennies apparently dissociate sufficient copper ion to kill the fungi and bacteria. In one case, an axolotl with the tail markedly deformed by a fungus infection was successfully treated by placing a penny in the aquarium for a two week period.

None of the non-warty, Bolder Creek, individuals became warty while in physical contact with warty individuals in the lab. We do not know what effect the various physical factors might have on the larvae or metamorphosing forms.

In conclusion, although the cause is unknown, the percentage of warty individuals of *Taricha torosa klauberi* from Boulder Creek, San Diego County, has apparently slowly decreased until today only 3 to 4 percent of the population is warty. As suggested by Twitty (1942), Myers (1942), and Stebbins (1951), recognition of the form does not now seem justified.

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Notes on the Lectotype of *Bufo woodhousi microscaphus* With Notes on the Specific Relationships of the Toads

By FREDERICK A. SHANNON

At the time I was trying to select a lectotype for Cope's *Bufo microscaphus*, I had two toads before me labeled USNM 4184. One of these, as stated in my paper[1] (p. 307), was a "normal appearing *B. w. woodhousii*," and the other I designated as the lectotype of *Bufo woodhousii microscaphus*. At the time, I believed Cope's original description[2] of his two cotypes was based on USNM Nos. 4106 and 4184. I thus believed that No. 4106 had been lost and that of the two different species of toads bearing the number 4184, Cope had had only the example of *microscaphus* before him. Dr. Cochran informs me that it was the practice of the United States National Museum to place the same number on all animals of a single species collected in the same place at the same time by the same person. After Dr. Stejneger took over in March, 1889, each specimen was given its own number, except tadpoles and eggs, which usually go under a single number per lot. Dr. Robert Stebbins[3] (p. 268) in discussing my choice of lectotype states, "in my opinion both toads are *microscaphus*, although the larger, pale individual . . . is a female, 69 mm. in snout-vent length . . . I am unsure which toad was chosen by Shannon as the type, but I suspect it was the smaller individual which to me is most typically *microscaphus*."

Dr. Stebbins was kind in his remarks. Actually there are obviously three toads in the U. S. National Museum bearing the number 4184. Of these, each of us saw the "larger, pale individual." The other that Stebbins saw "was the smaller individual." The second seen by me was much larger than the pale individual, with high keratinized cranial crests and warts. I believe that the confusion is explained by Stebbins (p. 267) when he notes that Dr. Doris Cochran informed him that the two cotypes were originally USNM 4106 but that "some clerk unfortunately made a double entry for this number and the two toads were later renumbered 4184." Unfortunately when the two toads were renumbered, another

[1] Shannon, F. A. 1949. A western subspecies of *Bufo woodhousii* hitherto erroneously associated with *Bufo compactilis*. Bull. Chi. Acad. Sci., 8 (15): 301-12.

[2] Cope, E. D. 1867. On the Reptilia and Batrachia of the Sonoran Province of the Nearctic region. Proc. Acad. Nat. Sci. Phila., (1866): 300-14.

[3] Stebbins, R. C. 1951. Amphibians of Western North America. Univ. of Cal. Press, pp. xviii + 539, pls., figs., maps.

double entry was made, and now three toads are numbered 4184. Again Dr. Cochran writes me that "USNM 4106 was originally 2 *Bufo columbiensis* from Upper Color. region collected by Mollhausen under Lt. Ives. Someone entered a *Crotaphytus collaris* from Coal Creek at 4106, and when the mistake was found, the 2 toads were removed to 4184. Several other entries on that page suffered the same fate. We have never heretofore recognized *microscaphus* in our card file, hence I don't see any other specimens here bearing that name." I am thus uncertain what has happened to the large *B. w. woodhousii* bearing the number 4184. It is unfortunate that I did not have the other *microscaphus* at the time I selected the lectotype, because, as inferred by Stebbins, the large pale individual, while obviously *microscaphus,* is atypical and a poor choice for a type specimen. Dr. Cochran has kindly restricted the number 4184 to the lectotypic specimen so that there will be no confusion in the future. The smaller, more desirable toad now bears the number USNM 132901.

I still adhere to my original stand that *microscaphus* and *californicus* are subspecies of *Bufo woodhousii,* and I believe the ranges of *microscaphus* and *w. woodhousii* to be allopatric. Stebbins (*cf.* above, pp. 266-280) presented the view that *microscaphus* should be elevated to a specific status with *californicus* as a subspecies. He regarded overlapping southern Nevada and Utah populations showing characters of both *microscaphus* and *woodhousii* to be hybrids rather than intergrades. The ultimate answer to the problem may lie in certain southwestern New Mexico and northwestern Chihuahua specimens, which resemble *microscaphus* and lie within the supposed range of *woodhousii.* If these specimens actually are *microscaphus* and their range is sympatric with that of *woodhousii,* Dr. Stebbins's conclusions will be supported. If, as I believe and hope to demonstrate, the specimens represent still another distinct allopatric subspecies, the weight of evidence will support my earlier conclusions.

WICKENBURG, ARIZONA

A Further Note on the Regurgitation of Artificial Eggs by Snakes

By CARL GANS

Smith (Herpetologica, 1953, 9, pt. 2: 93-95) recently presented a most interesting and complete case history of an instance of irregurgitability of an artificial (wooden) nest egg. Definite evidence was reported for the fact that the snake, a specimen of *Elaphe obsoleta lindheimeri,* could not regurgitate the egg by its own efforts. An attempt to force the egg forward manually beyond a certain point resulted only in rupture of the integument.

This report stands in direct conflict with a previous paper (Gans, Zoologica, 1952, 37: 215) in which the point was made that it would be exceedingly improbable for a snake to be unable to regurgitate any food object capable of ingestion. Specific reference was made to a china nest egg.

There exists, however, a class of objects that definitely may not permit regurgitation. This category includes objects that change their shape or proportion during or after swallowing. The literature is replete with case histories of snakes getting into difficulties of this type, mainly when attempting to swallow animals having erectile spines or fins. Cases of rupture following attempts to regurgitate bulky prey have also been reported (Howard, Copeia, 1949, 4: 289). It is probable that such rupture tends to occur primarily with those types of prey that exhibit step-like transitions in anterior and posterior longitudinal section.

In the case described by Smith, it has been established that the artificial egg was definitely present within the snake, but it would hardly be reasonable to assume that the snake had "shrunk" after ingestion. The minor differences in anterior and posterior shape could hardly offer any reason for difficulties, so that the only remaining possibility would be that the "egg" itself had changed, and consequently prevented regurgitation.

It is of interest to point out here that the nest egg was made of wood, which will, as is well known, swell noticeably upon immersion in water. Approximate values for the increase in cross-sectional area of dried wood after exposure to water (saturated conditions), as taken from H. D. Tiemann's "Wood Technology" (Pitman Publ. Co., 1942: 235-236), average around 15%. This value will be increased by the addition of various acids and wetting agents. An increase of 15% in the cross-section corresponds to an increase of about 3.8% in the diameter or circumference. For an egg with a diameter of 44 mm., this would mean an increase of the circumference of 5.3 mm., an increase which might well tax the extension powers of both esophagus and integument.

Ditmars (The Reptiles of North America. Rev. Ed., 1949: 232) states that *Elaphe obsoleta lindheimeri* does not break the shell by force immediately after swallowing, but rather waits until the gastric juices have thinned this sufficiently for it to be broken with little effort. If the specimen in question had indulged in this habit, the time elapsed would have been ample for the process to take place. Hence it seems more than possible that the egg had swollen to a diameter greater than that of the anterior esophagus by the time regurgitation was first attempted.

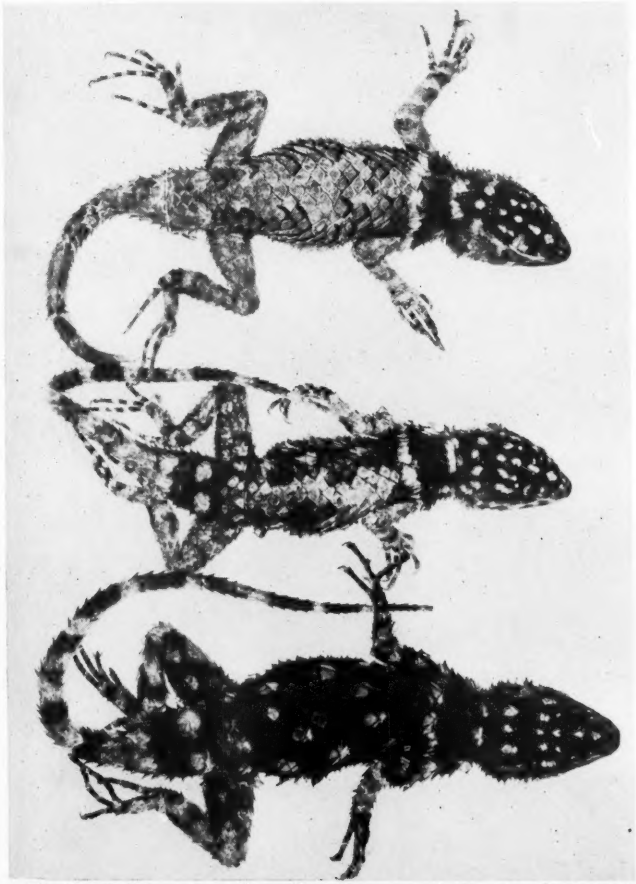
The reconstructed sequence of events follows: The snake swallowed the wooden nest egg, which was just small enough to pass the anterior esophagus. The egg was then retained in the stomach for a time, the larger diameter of this organ permitting it to swell unrestrictedly without discomfort to the snake. By the time the snake discovered that the shell of this "egg" could not be broken, the egg was already too large to permit it to pass the esophagus, and regurgitation had become impossible.

SECTION OF HERPTILES, CARNEGIE MUSEUM
PITTSBURGH 13, PENNSYLVANIA

A New Lizard of the Genus *Sceloporus* From the Isthmus of Tehuantepec

By HOBART M. SMITH *and* CARLOS B. BUMZAHEM

Among the specimens recently collected by Mr. Thomas MacDougall in the vicinity of the Isthmus of Tehuantepec is a series of 8 specimens of *Sceloporus* of the *torquatus* group. These specimens are from an area formerly devoid of records of any member of the *torquatus* group; they appear to represent a distinct species. Furthermore, *S. serrifer* and *S. cyanogenys* are the only other species occurring at such low elevations, near sea level; no other whatsoever is known to reach equally low elevations on the Pacific coast.



Pl. 1. *Sceloporus macdougalli.* Top, male holotype, UIMNH No. 34354; middle, immature male paratype, UIMNH No. 34355; lower, female paratype, UIMNH No. 34357.

Sceloporus macdougalli sp. nov.

Holotype. Univ. Ill. Mus. Nat. Hist. No. 34354, an adult male from Rincón Bamba, 22 miles SW of Tehuantepec, 8 miles from the coast at Bahía Bamba, Isthmus of Tehuantepec, Oaxaca, Mexico, Mar. 26-27, 1953.

Paratypes. Seven, including UIMNH 34355-9, Univ. Mich. Mus. Zool. No. 109211, and Chicago Natural History Museum No. 71661, all topotypes collected by Mr. Thomas MacDougall.

Diagnosis. A member of the *torquatus* group, with a dorsally complete, light-bordered nuchal collar 4 scales wide; supraoculars large and in a single series; femoral pores 11-17; dorsal scales 28-29; females black above with rather large (2-3 scales) scattered blue spots above in three rows on each side; mature males all light blue above posterior to collar.

Pl. 2. *Sceloporus macdougalli,* from holotype, UIMNH No. 34354.

Description of holotype. Head moderately elongate; interparietal large, larger than entire frontal; frontal undivided; 5 very broad supraoculars separated from superciliaries by one row of small scales and 2 or 3 extra scales, and from median head scales by one row of small scales; 2 canthals; 4 postrostrals; 1 loreal; preocular divided, lower part small; a very elongate subocular; a total of six superciliaries, 5 visible from above.

Two rows of labiomentals, the outer not reaching mental, the inner extending anteriorly to a point even with the suture between the second and third infralabials on the left side of the jaw and extending a little farther on the right side of the jaw; posterior gulars notched.

Scales of back weakly keeled, mucronate, not denticulate, those on tail and hind limbs more spinose; femoral pores 15 on right limb and 17 on left limb; dorsal scales 29 from occiput to base of tail; lateral belly patches distinct. Snout to vent 73 mm.; tail 76 mm. (incomplete); snout to posterior border of ear 20 mm.; fourth toe 14 mm.

Bluish-green above from posterior border of nuchal collar to level of anterior insertion of hind limbs, black anteriorly except for a pattern of small blue spots; tail banded dorsally and laterally, undersurface of tail white; digits banded with light blue; nuchal collar black, with an incomplete anterior light border.

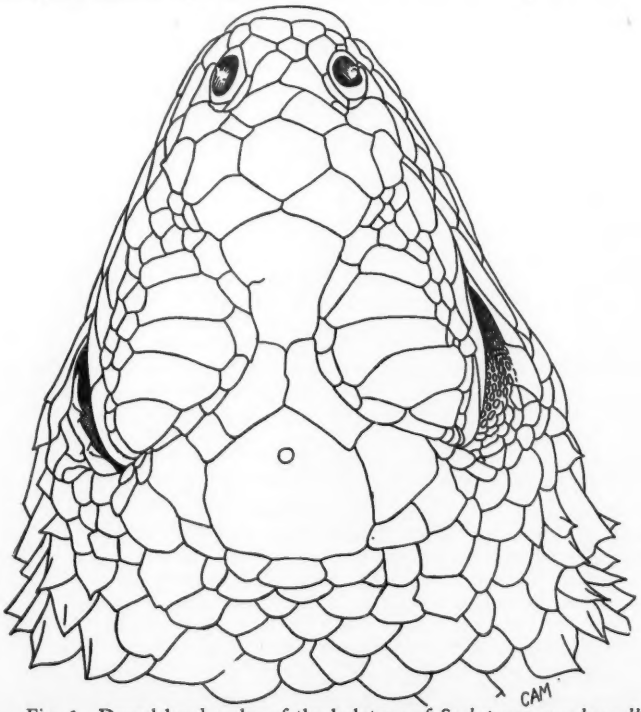


Fig. 1. Dorsal head scales of the holotype of *Sceloporus macdougalli*, UIMNH No. 34354.

Head black with blue spots arranged in what appears to be a constant pattern: a spot behind both parietals and one behind the interparietal; a spot on both parietals and the interparietal; a spot at the posterior corner of each eye; a large spot at the suture between the third and fourth supraoculars, and a smaller spot on the fifth supraocular; a spot on the small scales of the anterior corner of the supraocular region; a large spot at the junction of the frontal and frontonasals; a spot on the internasals. Lower surfaces of body and limbs white, tinged with blue, except on sides of abdomen, which are moderately dark; groin black; gular region changing from a grey anteriorly to a grey-blue posteriorly.

Variation. The paratypes agree with the holotype in head scalation except that the frontal varies considerably. In UIMNH No. 34355, a smaller male, it is undivided; in Nos. 34356, 34358 and CNHM No. 71661, it is divided; No. 34357 has a divided frontal, the front half of which is partly broken up into small scales; UMMZ No. 109211 has a small scale between the frontal and frontoparietal touching the row of scales medially bordering the right supraocular. There is also a great variation in the number of femoral pores, the two sides counted separately yielding the following frequencies: 11, one; 13, one; 14, five; 15, three; 16, two; 17, two.

There is but slight variation in the number of dorsal scales, 2 having 28 and 5 having 29 as the holotype. In UIMNH No. 34355, no median suture separates the frontoparietals, the suture separating the left frontoparietal from the interparietal continuing across to the row of small scales medially bordering the right supraoculars. In none of the paratypes does the preocular appear to be as distinctly divided into a large and a small element, the large element being the only one that can be discerned with certainty.

The largest female, UIMNH No. 34357, measures 82 mm. snout-vent, the tail 118 mm.

This species exhibits a remarkable sexual dimorphism in color and pattern, affecting the dorsal as well as ventral surface. One paratype, UIMNH No. 34355, is a smaller male which agrees essentially in coloration with the holotype, except that the background is darker and the light spots more distinct, suggesting that still younger examples probably closely resemble females. The other six paratypes are females and are different in retaining the black juvenile coloration, having a black dorsum with 6 rows of blue spots, about 4 in each medial row; tail dark, with blue bands, and the limbs also black, so spotted as to appear banded. The body spots cover an area of 1½ to 2 scales. The spotting on the head is the same as that of the holotype. Only faint evidence of the blue spots on dorsum of the trunk remain in the type male.

Comparisons. It appears that *macdougalli* may be placed in that subgroup containing *serrifer, bulleri,* and *torquatus,* all of which are large-scaled species with supraoculars in one row. It differs from *serrifer* in generally having more than 14 femoral pores, from *bulleri* in having fewer dorsal scales, and from all in coloration. The irregular frontal is distinctive in this subgroup. The very large supraoculars, as well as geographic and perhaps ecological position, indicate a very primitive status in the phylogeny of the group.

MUSEUM OF NATURAL HISTORY, UNIV. OF ILL., URBANA

The Courtship Pattern of the Box Turtle, *Terrapene c. carolina*

By L. T. Evans

In the light of the discovery that the rear claws of the male box tortoise very probably represent secondary sex characters (Evans, 1951), a reexamination of the mating pattern of *T. carolina* has been made in an attempt to define more clearly the part played by the rear claws of the male.

An analysis of the data collected from 72 matings between 3 mature males and females, shows that courtship is divided into 3 phases: 1, the circling, biting, and shoving phase (fig. 1); 2, the preliminary mounting phase, during which the rear claws of the male rest upon the lateral edges of the rear plastron of the female and are held firmly in position by the closure of the plastron (figs. 2 & 3); 3, the copulatory phase, during which the female's plastron is partially relaxed, the male's rear claws remain upon the edges of the plastron, while the female's rear legs move medially to hold them in place as described by Cahn and Conder (1932), or the male's rear claws hook over the lower legs of the female. Subsequently, the male leans backward with his plastron sloped posteriorly several degrees from the vertical position. Coition can now take place (fig. 4).

In phase 1, the male approaches the female but stops when about 4 inches away, with his legs straightened, his head held high, and often with one leg raised above the ground. The female rather habitually retracts her head but watches him. The circling act consists either of walking around the female, nipping her shell as he goes; or of pushing her shell a few degrees upon its axis, then biting it, then pushing it farther around, and biting it again. Occasionally he grasps the edge of her carapace in his jaws and drags the female several inches, moving backward as he goes. Still more rarely the male lunges forward, striking the female's shell a glancing blow with the forward edge of his plastron. During these lunges he ducks in his head just before the impact, looks out cautiously, then hurls himself forward again. Each forward thrust spins the female partly around and he shifts his aim before lunging again.

Several minutes or even an hour might elapse during phase 1, depending upon the readiness with which the female opens her plastron. There are occasions when the male mounts before the plastron opens. If phase 1 has been sufficiently stimulating to the female, the contact of the male's plastron with the female's carapace, and the male's rear claws reflexly exploring for the edge of the plastron serve as successive "releasers,"* causing the female quickly to relax her plastron. Almost in-

*The term "releaser" as defined by Lorenz (1937): "All such devices for the issuing of releasing stimuli, I have termed *releasers* (Auslöser), regardless of whether the releasing factor be optical or acoustical, whether an act, a structure or a color." Tinbergen (1948) emphasizes the relationship between releasers and innate behavorial patterns.

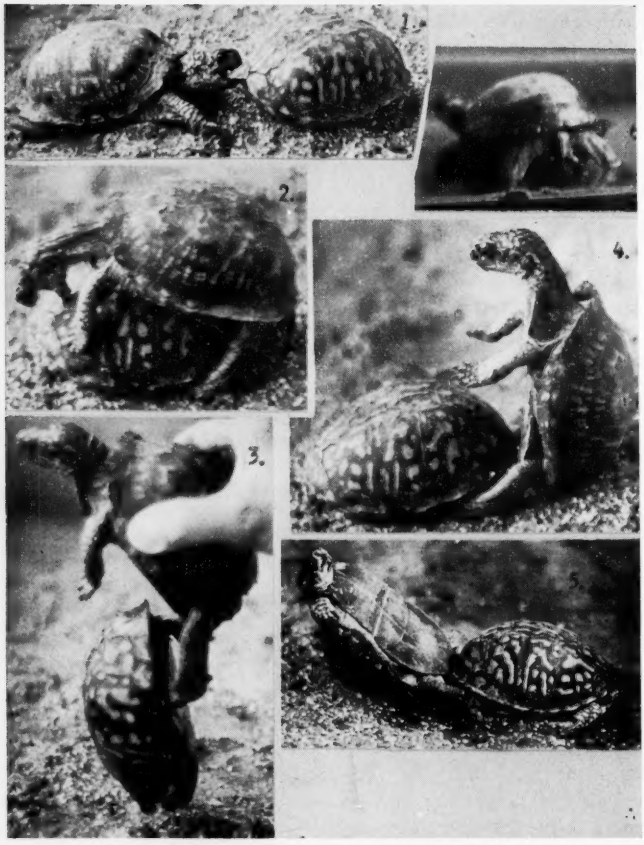


FIGURE 1. Courtship of *T. carolina,* phase 1. The male bites and pulls at the edges of the female's carapace; 12:31 p.m. Figures 1, 2, 4, and 5 from photographs taken June 7, 1951.

FIGURE 2. Phase 2, 12:43 p.m. The male mounts the female. His rear claws have hooked upon the lateral edges of the posterior half of the female's plastron, which has just closed. This holds the claws tightly.

FIGURE 3. Shows the gripping power of the female's plastron upon the rear claws of the male in phase 2.

FIGURE 4. Shows an early aspect of phase 3. The plastron of the female is beginning to relax but her ankles have not yet emerged to press against his rear feet. 1:16 p.m.

FIGURE 5. Shows a late aspect of phase 3. The ankles of the female press upon the rear feet of the male, lending leverage to permit him to lean backward. 1:57 p.m.

FIGURE 6. The posterior view of the male, showing the penile erection.

stantly the male's claws hook on; then the plastron holds them tightly. At times the plastron opens at almost the same instant the male mounts, at others a few seconds later, after his rear claws scratch her shell. It seems that the titillation of the claws upon the postero-lateral edges of the female's carapace is the final "releaser" to induce the opening of the rear plastron, bringing in phase 2.

Once phase 2 is entered, the male's rear feet follow the edge of the plastron forward and when near the hinge, which divides the plastron into anterior and posterior halves, the claws hook over it and the rear plastron closes up (fig. 2). The plastron probably has greater gripping powers laterally. At the same time the equilibrium of the male is more stable with his legs widely spread. More space is thus afforded between them for coition to occur, which is important since the penis is about two inches wide when fully erected (fig. 6).

The "releasers" which bring about a shift to phase 3 consist (1) in the contact-friction of plastron upon carapace, (2) the sensations produced when the male's head projects down in front of her own, when he bites the forward edge of her shell, (3) the touch of his forefeet upon her shell, and (4) finally the slight motion of his pinioned claws on the plastral edge. The very considerable gripping power of the plastral hinge is illustrated in fig. 3, which shows the male supporting the weight of the female by his rear claws. Such a picture can be obtained whenever phase 2 is entered in a normal mating.

In phase 3 the male slips backward until his carapace rests on the ground. He leans backward while the rear ankles of the female press downward and medially upon his feet which have shifted farther in upon the plastron. This action brings the two cloacae together, as the two tails lie parallel. After several seconds the male leans still farther back (fig. 5), then returns to the vertical position again, as in fig. 4. Intromission is now possible, and with each rearward leaning of the male, the penile thrusts become greater until coitus is effected. Well over two hours might be consumed in phase 3, while the entire courtship might last six hours.

The first "releaser" of phase 3 is probably the relaxation of the rear plastron by the female. This induces the male to slide backward upon her carapace to rest his rear upon the ground. This action relaxes his rear feet and their movement medially is probably the "releaser" which causes the ankles of the female to press against them. The subsequent friction between their tails "releases" the actual copulatory movements.

The sequence of events as described seems to be the normal courting pattern. If the male is too hasty in passing from one phase to the next, the female fails to respond or her response is negative. For example, if the male mounts before a minimum but variable period of circling and biting, the female does not relax her rear plastron to usher in phase 2. Again, if the male moves backward upon her carapace in an attempt to pass to phase 3 too hastily, the female does not relax to permit coition. On the contrary, she might even start crawling forward, using her forefeet only, thus dragging the pinioned male several feet across the ground. He frequently falls off in this situation, and strains violently to free his tightly held toes. In the ensuing struggle, the male's legs become wrenched or twisted badly, for he limps away when he finally succeeds in breaking loose. For the next two or three hours the male is most reluctant to move about.

In view of the relatively enormous penis in this species, it is not surprising that complete cooperation by the female is absolutely necessary to consummate the courtship. Fig. 6 shows the extruded organ as the male stands in a shallow pan of tepid water. His rear legs are fully extended while his forelegs are flexed. This position is often assumed by active mature males and by juvenile males that have received implants of male hormone. When first extruded, the penis is cylindrical, then it spreads out into the shape of a thickened spoon. The hemostatic nature of the erection of the penis is revealed in the change of color from brown to deep red as the lateral expansions appear. The color changes to brown again as the organ is withdrawn, approximately thirty seconds later. No reason is offered for the "extra-sexual" erection, but it is interesting to note that it occurs very often in those males which evince considerable sexual interest in females.

An indication that the mating as described is normal appears in the fact that 11 eggs were laid by the three females during the two years they were under observation. Five of these eggs were incubated in moist soil sufficiently to ascertain that they were fertile. The females had access only to the three males used in this study.

SUMMARY

A study of 72 matings reveal that the normal courtship comprises 3 phases. Phase 1: The male circles the female or pushes her around with a forefoot, while biting at the edges of her carapace. Phase 2: The male mounts the female, while scratching her carapace with his rear claws. She opens her rear plastral plate and the rear claws of the male quickly hook upon its lateral edges. The female then clamps the plastron shut, pinioning the male's rear feet. For the next several minutes or hour the male protrudes his head to snap at the face of the female and to bite at the forward edge of her carapace. Phase 3: The female relaxes the plastral grip upon the male's claws. He slides backward to rest his shell upon the ground, and to move his rear feet inward upon her plastron. Her rear feet press medially upon the male's feet. This gives support to his legs as he leans backward to bring his cloaca close to hers to effect coitus.

The part played by "releasers" (Lorenz) in the courtship pattern is discussed. Considerable variation occurs in the sequence of events leading from one phase to the next.

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The Status of the Whipsnake *Masticophis flagellum* (Shaw) in Colorado

By T. Paul Maslin

A few years ago Smith (1941) and Klauber (1942) independently concluded that the black whipsnake *Masticophis flagellum piceus* (Cope) does not fit our current concepts of a geographical race but merely constitutes a color phase of *M. f. frenatus* (Stejneger). Smith (*loc. cit.*) also pointed out that the name *frenatus* is not available, and therefore, *Masticophis flagellum piceus* (Cope) must be applied to all color phases of the western whipsnake.

This treatment of the color phases of *M. f. piceus* is pertinent to a problem concerning *M. f. testaceus*. This race as it is understood by most authors is a brown form inhabiting extreme southwestern Nebraska, western Kansas, southeastern Colorado, western Oklahoma and Texas, all but the extreme southern portion of New Mexico, and south into Mexico from central Texas and extreme southeast New Mexico. It has generally been overlooked that a red phase of this race exists in Colorado although reddish individuals have been reported from the central areas of its range. As recently as 1937, however, Gloyd (p. 18, footnote) commented on a red specimen he collected near Pueblo. The problem with which this paper is concerned is whether to recognize this red phase of *M. f. testaceus* (Say) as a distinct subspecies, or whether to consider it as a color phase of this subspecies in the same manner that Smith and Klauber have considered the black whipsnake a color phase of *M. f. piceus*.

Historical Background

In the years 1819 and 1820 Major Stephen H. Long led an expedition to the Rocky Mountains. Members of his party included Mr. Edwin James, botanist and chronicler, and Dr. T. Say, zoologist. On the 16th of July, 1820, after a trying march through barren lands they dropped down into the valley of the Arkansas River and camped. Here they remained for several days, collecting and exploring. As this campsite turned out to be the type locality of a number of organisms, Thwaite (1905, v. 16, p. 32) took pains to locate the site with greater exactitude than did the explorers themselves. From James' account of their route and from their map it appears that they camped near Turkey Creek, 12 miles up the Arkansas from its junction with the Fountain River. I have visited the area and Thwaite's location of the site seems logical. The travelers arrived at the river but, encumbered with gear and pack animals, could not from their point of contact, descend the arid bluffs to the wooded grassland of the flood plains itself. This suggests that they reached the river several miles above its junction with the Fountain River where the descent would have presented no problems.

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The nearest feasible descent this far up river would have been down the gully formed by what is now known as Turkey Creek. I suggest then that this campsite be described for nomenclatorial purposes as "junction of Turkey Creek with Arkansas River, 12 mi. W. Pueblo, Pueblo Co., Colorado."

The following day, James (1823, p. 236, London Edition) relates, "A fine species of serpent [30] was brought into camp by one of the men. It is new, and seems to be peculiar to this region." There then follows in a note Say's description of this species (quoted from the Philadelphia edition, volume 2, p. 48):

"Genus Coluber, Lin.

† 2. *C. testaceus.* Pale sanguineous, or testaceous above, beneath sanguineous, immaculate.

Plates 198, scales 80?

This is a large species, which inhabits near the Rocky Mountains. It moves with great rapidity, and in general form and size resembles *C. constrictor.* The scales are large. A specimen is in the Philadelphia Museum."

Holbrook (1842, v. 3, p. 63) recognized Say's species and redescribed it. His description of one specimen was apparently based on the type as is the full page color plate (pl. 13), although the type has subsequently disappeared.

Then, ten years later Hallowell (1852) described another species *Psammophis flavi-gularis* from Cross Timbers, Oklahoma. The following year Baird and Girard (1853) in their catalog of North American reptiles recognized this species and commented on specimens of it described by a Mr. Clark from the Upper Rio Grande (Presidio del Norte, Mexico) which showed a decided tinge of red. In reference to *P. flavigularis* they state (loc. cit., p. 159) "It would not surprise us therefore, to find it the same with *Coluber testaceus,* Say—a point of much interest, as this is the only one of Say's Western species which we have not identified as clearly distinct." They did not recognize Say's species which, though based on a single specimen which must have been available to them, had not been recollected for thirty-three years. They must also have been reluctant to reduce the clearly recognizable *P. flavigularis* to the synonymy of such a dubious species.

Further collecting in the southwest soon made it apparent that the whipsnakes were widely distributed. Baird and Girard's (1853) implication of intergradation between *flavigularis* and *testaceus* and the fact that while no other specimens of red *testaceus* were forthcoming the name did have priority, opened the way towards recognizing *testaceus* and reducing *flavigularis* to the status of a synonym. Thereafter, except for shifts in the generic name, *testaceus* became fairly well established as the proper name for this southwestern snake. Jan (1863) was the first to recognize it as a subspecies of *flagellum.* In this he was followed by Yarrow (1875) who had only the previous year collected a specimen of *testaceus* from Pueblo, virtually the type locality.

Cope (1860) at first used the name *Coryphodon testaceus* in connection with red whipsnakes from farther southwest. He then evolved during the next forty years through considering it a subspecies of *flagellum* to not recognizing the southwestern whipsnakes as racially distinct at all. Other authors of this period vacillated in much the same way. It was not until Ortenburger (1923) clearly differentiated the genera *Coluber* and *Masticophis* and incidentally treated *testaceus* as a synonym of *Masticophis flagellum flavigularis,* that uniformity prevailed. Blanchard (1925) in his influential key followed Ortenburger and after Ortenburger's (1928) exhaustive monograph of the whipsnakes and racers this name became thoroughly established.

Ortenburger (1928, p. 94) explains his reasons for not accepting the name of *testaceus* in the following words. "Say merely described it as a 'pale sanguineous or testaceous' snake, and gave it the name *Coluber testaceus.* His description, however, is too uncertain to warrant using this name. In 1852 Hallowell described what is without much doubt this

same species, calling it *flavigularis*." Finally Klauber (1942, p. 23, footnote) rightly took exception to this line of reasoning. He pointed out that while the description is brief it fits no other snake found in the region, and that the name *Coluber flagellum testaceus* Say should be applied to this prairie subspecies. Currently this species and the other racers with slender attenuated bodies are placed in the genus *Masticophis* and the name now applied to the prairie whipsnake is *Masticophis flagellum testaceus* (Say).

Collecting in the 19th century west of the Rocky Mountains had revealed that a red form occurred in the west. As this form fitted Say's brief description quite adequately the name *testaceus* was promptly applied to it. But among these western specimens black individuals soon were found to which Cope (1875) allocated the name *Bascanium flagelliforme piceum*. And finally Stejneger (1893) differentiated the western red racers to which he applied the name *Bascanium flagellum frenatum*.

These forms were generally recognized by herpetologists subsequent to their description. Ortenburger (1927) even went so far as to give *piceus* full specific rank. But as was pointed out in the first paragraph of this paper Smith (1941) and Klauber (1942) both concluded independently that the black form is, in reality, a color phase of the predominantly red race of the western whipsnake.

The red phase of *Masticophis flagellum testaceus* (Say)

My attention was first drawn to the occurrence of a red whipsnake in Colorado by a student, Mr. W. N. Horstman, who kindly collected two specimens. An attempt was then made to work out the distribution of this form. Over a period of several years 14 specimens have been collected. While this number is not great it demonstrates clearly that a red form exists in the Arkansas River valley of Colorado, to the exclusion of all other color phases. Snakes from the vicinity of Pueblo and west to Canyon City are a brilliant red above and a bright pink below. Points to the north, east and south of this are occupied by less brilliant snakes until finally in the extreme eastern portion of the river drainage in Colorado the specimens are pale pink and intergrade in this character with the brown snakes of northeast Colorado, Nebraska, Kansas and Oklahoma.

The ventral counts of the eight male snakes in the University of Colorado Museum have a mean value of 200.1 ± 1.1 (standard deviation $2.85 \pm .76$). The subcaudal counts are insignificant in that in most if not all of the specimens the tail is mutilated. The ventrals of the six females have a mean value of 197.5 ± 1.2 (standard deviation $2.65 \pm .84$), in these also the tails are apparently incomplete. Pre and post oculars of both sexes are uniformly two and two; supralabials invariably 8 - 8, fourth and fifth entering the orbit; infralabials 10 or 11; temporals $2 + 2 + 2$, occasionally a supernumerary appears at any level; scale rows 17 - 17 - 13, one specimen, a male, with 12 rows before the vent. The largest snake, a female, measures 118 cm. from snout to vent and has a 22 cm. mutilated tail. The ventral counts are high for the species; but this character forms the extreme of a cline involving an increase of ventrals from south to north and cannot be used as a diagnostic character.

The color pattern characters commonly used in differentiating races of *M. flagellum* are relative characters exhibiting a considerable amount of variation. The Colorado whipsnakes strike a mode in respect to many of these characters so that a loose interpretation of the description of most whipsnakes of this group would fit a Colorado specimen. The red

coloration of these forms tends to disappear in preservatives leaving the melanin pattern scarcely affected; what pattern there is is dependent on these darker pigments over which the red is superimposed.

In general scales on all parts of the body tend to be darker posteriorly and lighter anteriorly; but this basic distribution of pigment is modified in various ways. Anteriorly the dorsal scales tend to have the melanin confined to a central area, thus approaching the streaked scales of *M. f. lineatulus* Smith. In some specimens this streaked condition is strongly developed. That part of each scale overlapped by adjacent scales is cream colored. Furthermore the edges of each scale are so much lighter than the centers that a strong tendency exists toward the formation of narrow light stripes between scale rows. This is particularly apparent in young specimens. Posteriorly the dark streak on the scales widens but the creamy basal portion increases in area. Usually this area forms a narrow zone following the contour of the overlapping scales, but there is a strong tendency for the creamy area to extend posteriorly on the scale thereby losing all correlation with the pattern of the overlapping scales. In extreme cases the posterior half of a scale may be dark from edge to edge and the anterior half creamy white. In addition to this conspicuous pattern the extreme edges of all the dorsal scales are dark brown or black. This gives the snake the appearance of a neat drawing, with the more obvious color pattern shaded in.

The head is darker than the ground color. This darker color extends posteriorly to and includes the second row of occipital scales then arches forward laterally below the last infralabial. In young specimens this dark area is narrowly bordered by a light penumbra. The darker head scales show the same trend as the body scales. Anteriorly each plate has a narrow light edge; and in some specimens this light edge also appears on the medial edge of each plate. The posterior and lateral edges of these plates are usually marked with a narrow, darker border.

The same trends appear in the facial scales but less obviously so. The loreal and labials are each marked with a white truncated triangle, so arranged that the base of the triangle occupies the center of the anterior edge of the scale. In some snakes the triangle on the loreal is so large that it nearly cuts across the scale (but never completely crosses it as in *M. f. frenatus*). The triangles are often large enough, however, to cut through the supralabials thereby producing an irregular light line. In young specimens both the pre- and postoculars are white. All of these darken with age except the upper preocular which remains creamy white (in all specimens available) in even the largest specimens.

The ventral surface of the head is normally a creamy white but the sutures between the scales tend to be mottled with dark grey or brown. This is particularly true of the longitudinally arranged sutures. In those snakes in which this character is weakly developed only the posterior edge of the mental and the medial edges of the infralabials are darkened.

The ventrum is marked by four series of light-centered, dark, truncated triangles, whose bases are on the posterior edges of the ventral scales. Anteriorly these triangles extend a little less than half the distance across a ventral. The paramedial series occur on each ventral, but the lateral series are irregular, frequently occurring on every second or even third ventral. Very shortly posterior to the neck the paramedial spots become less distinct but longer and may join each other to form two longitudinal, reddish-brown stripes. These stripes or spots fade out completely before

the level of the first fifth of the body is reached. The lateral series are never as distinct but persist farther posteriorly and come to appear on each ventral. These series may overlap another series of marks which posteriorly consists of diffuse grey lateral borders to the ventral scales. These grey borders cover the lateral third or more of each ventral in such a way that the mid-belly region is immaculate. Anteriorly these lateral borders narrow until at mid-body they consist of a series of diffuse grey spots at the extreme lateral edges of each ventral. The anterior lateral series of marks usually merges into this posterior series giving the impression of a single series, but in some specimens they do not overlap and for a short distance near mid-body the ventrals are completely immaculate.

The transverse dorsal bands which appear in several forms of the *flagellum* group are evident in these Colorado specimens. It has long been assumed that the primitive color pattern of snakes consists of at least three series of spots on each side, the paravertebral pair being opposite each other and the largest. The lower series are successively smaller, the spots in each of these series alternating with the larger spots of the series above. By appropriate enlargement and fusion of two pairs of paravertebral spots and the alternating spot between and below them a large hexagonal middorsal blotch can be produced. This seems to be the manner in which the vertebral series of saddle-like marks has evolved in many genera of colubrine snakes. Now according to Maslin's (1952) first principle of divergence any trace of saddle-like marks in a genus characterized by a lack of such a pattern should be primitive in regard to this character. In some specimens from Colorado extremely large saddle-like marks can be clearly recognized. The entire saddle is slightly darker than the ground color but its anterior and posterior edges in particular are much darker. This entire saddle is approximately 16 dorsal scales in length and is separated from the next saddle by a distance of about 14 dorsal scales. The dark margins of this saddle are from 1 to 2 scale lengths in width. This type of pattern has been described as the wide-banded type by Ortenburger (1928: 94). The narrow banded type is not simply the same pattern made up of shorter saddles, as one might expect. It is, instead, a new pattern complex superimposed on the large saddle plan. A young Colorado specimen (U.C.M. No. 3162) shows the broad-banded pattern anteriorly, but within the broad bands about five irregular transverse bands are apparent. Gloyd (1937) has noted the same phenomenon on another specimen from Colorado. These bands are about a scale length wide and are separated from each other by a distance of about one and one-half scale lengths. The dark color is not confined to complete scales but may cross scales irrespective of their borders. Between the broad bands on the lighter ground color about four additional transverse bands appear. The dark color of these bands is inclined to be confined to complete scales. They also are one scale length wide, but are separated by about two scales and are not as dark as the former. The complete pattern then consists of about seven (anterior and posterior borders of the wide band are here included) dark narrow bands, separated by about 1½ scale lengths followed by a group of about four lighter bands on a lighter ground color and separated from each other by the length of about two scales. In larger specimens this grouping of narrow bands is less apparent, especially in long preserved material, and in many specimens the secondary bands are so poorly developed as to be nearly invisible. This indistinct phase of the pattern is nicely illustrated

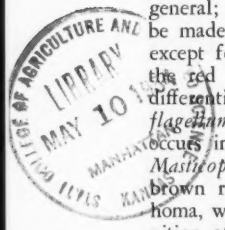
in Ortenburger's (1928, p. 16) photograph of *M. f. flavigularis.* In general the Colorado snakes resemble these.

Posteriorly the secondary bands are fainter but more evenly spaced (one scale length wide and one scale length apart), are all of the same color value, and form posteriorly directed chevrons. In adults this part of the pattern often fades out completely. There is then no true metamorphosis in color pattern in these snakes but rather a dedifferentiation of pattern during ontogeny tending towards a completely patternless condition. This end point is frequently reached in *M. f. flagellum,* but less frequently in other races so that the patternless condition constitutes a derived extreme of a fairly obvious morphocline.

The red color of Colorado whipsnakes is superimposed over the melanin patterns described above. It is darkest on all dorsal surfaces. Anteriorly the ventral surfaces are a pale pink becoming darker posteriorly. Posterior to the vent the color is nearly as dark as that of the dorsum. Towards the periphery of the range the red color is much lighter and is evident as a pink suffusion in the lighter parts of the pattern.

DISCUSSION

It is apparent from the description above that the Colorado whipsnakes are not sharply differentiated from other races of the species *M. flagellum.* Most differences are relative, as are subspecific characters in general; but these relative differences are slight. The same criticism can be made of the differentiation of subspecies in most whipsnakes which, except for color, are remarkably similar. In this connection I feel that the red color of the Colorado whipsnakes is an adequate character in differentiating this form. I therefore suggest that the name *Masticophis flagellum testaceus* (Say) be restricted to that form of the species which occurs in the Arkansas River drainage of Colorado and that the name *Masticophis flagellum flavigularis* (Hallowell) be resurrected for the brown race occurring in N.E. Colorado, S.E. Nebraska, Kansas, Oklahoma, western Texas, New Mexico and parts of old Mexico. This recognition of a red race may at first seem at variance with the action taken by Smith (1941) and Klauber (1942) in their treatment of the black phase of *M. f. piceus* (Cope). The situations, however, are not quite parallel. The black phase of *M. f. piceus* is an example of melanism, a phenomenon of wide occurrence in animals, and one which has seldom led to the recognition of races. The case of a pure black form of *Thamnophis elegans atratus* (Kennicott) on the San Francisco Peninsula, California, may be cited as another example. Furthermore the black phase according to Klauber (1942) never occurs in any area to the exclusion of other color phases. A brief synonymy and diagnosis of this race is here included.



Masticophis flagellum testaceus (Say)

1823 *Coluber testaceus* Say, in James, E., Account of an expedition from Pittsburgh to the Rocky Mountains, 2: 48 (footnote); Holbrook, 1842, North American Herpetology, 2nd ed., 3: 63, pl. 13.

1853 *Masticophis flavigularis* (Hallowell), (part) Baird and Girard, Catalogue of North American Reptiles in the Museum of the Smithsonian Institution, pt. 1: 99, 159.

1863 *Masticophis flagelliformis testaceus* (Say), Jan, Elenco sistematico degli ofidi: 65.

1875 *Bascanium flagelliforme testaceus* (Say), (part) Yarrow, Rep. Geog. Geol. Explor. Surv. W 100th Mer.: 542.

1913 *Zamenis flagellum* (Shaw), Ellis and Henderson, Univ. Colorado Stud., 10: 104.

1923 *Masticophis flagellum flavigularis* (Hallowell), (part) Ortenburger, Occ. Pap. Mus. Zool. Univ. Michigan, 139: 2; (part) Blanchard, 1925, Pap. Michigan Acad. Sci., Arts & Let., 4: 38-39; (part) Ortenburger, 1928, Univ. Michigan Stud., Mem. Univ. Michigan Mus., 1: 92; (part) Gloyd, 1937, Bull. Chicago Acad. Sci., 5: 118 (footnote); Jones-Burdick, 1939, Univ. Colorado Mus. Lefft., 1: 6.

1942 *Coluber flagellum testaceus* (Say), (part) Klauber, Copeia, 1942: 93 (footnote).

1949 *Masticophis flagellum testaceus* (Say), Jones-Burdick, Univ. Colorado Mus. Lefft., 5: 11.

Type locality. Junction of Turkey Creek with Arkansas River, 12 mi. W. Pueblo, Pueblo Co., Colorado.

Type. The type, collected by a member of Long's Expedition and sent to the Philadelphia Academy of Science, has since become lost or destroyed. As no syntypes are known, nor are there any other specimens known from the type locality, the designation of a neotype must wait until suitable material is available.

Diagnosis. A whipsnake of the species *M. flagellum* (Shaw), which intergrades with only one other race, *M. f. flavigularis,* from which it differs in having a red color superimposed on an indistinct pattern made up of brown pigments; in having series of light lateral stripes running between the scale rows in the neck region; in having a head slightly darker than but sharply defined from the ground color of the body; and in having a creamy white (light red in life) upper preocular.

It differs from *M. f. piceus* in lacking a light streak through the loreal. A light spot is present on the anterior edge of this scale but this never extends completely across the loreal. It further differs from this subspecies in having a higher ventral count (♂ 200.1 ± 1.1, S. D. 2.85 ± .76; ♀ 197.5 ± 1.2, S. D. 2.65 ± .84).

It differs from *M. f. flagellum* in having a red coloration, and in having four longitudinal series of spots on the ventral scales of the anterior fifth of the body.

As it is isolated by considerable distance and intervening subspecies from *M. f. lineatulus, M. f. lineatus* and *M. f. variolosus* there is no need to compare *M. f. testaceus* from these well differentiated forms.

Range. Arkansas River valley and drainage area of Colorado below 6,000 feet.

I herewith wish to thank the Council on Research and creative work of the University of Colorado for monetary assistance in connection with this work.

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